

The Molluscan Land Operculate Genus *Liarea*

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Abstract.

Over 3,000 specimens from 150 localities in the North Island of New Zealand were used in this taxonomic and distributional survey. There are two groups of species in *Liarea*, one with a simple suture and the other with a margined suture.

A feature of the simple sutured group is the hydrophanous epidermal pattern, which varies with the age of the individual and is best developed under conditions of maximum alternation of wetting and drying. Two new species and five new subspecies are described.

INTRODUCTION.

The genus *Liarea* is restricted to the North Island of New Zealand with its maximum development in the Northland Peninsula, only sporadic occurrence south of there and complete absence from the Central Plateau and East Coast south of the Bay of Plenty.

According to Thiele (1929) the genus belongs to the *Pupinidae*, which he makes a subfamily of the *Cyclophoridae*. His associated genera are all of Indo-Malayan-Australian occurrence and the assumption is that *Liarea* is a relatively recent acquisition from that region.

There are no known fossil occurrences for *Liarea* other than those from post-Pleistocene consolidated dunes near Cape Maria van Diemen, so there is no positive indication of the length of time these snails have been in New Zealand. The fact that *Liarea* is mainly of northern North Island occurrence may be due to climatic rather than to time considerations, but on the other hand the comparatively large number of not very clearly differentiated local forms suggests segregational trends during a late stage of topographical development.

Even at the assumed specific level there are no strongly marked divergences and there is evidence in the species *ornata* that two groups, (A) *hochstetteri* with a margined suture and (B) *egea-turriculata* with a simple suture, have been closely enough allied in the not very distant past to enable the production of hybrid stock. Even now there are no very marked differences in the dentition of the several species representative of the two groups so far examined. All the group (A) *hochstetteri* series have a widely expanded labial flange and all but one, *ornata*, are without an epidermal pattern. In the group (B) *egea-turriculata* series the labial flange ranges from subobsolete to wide, and most of the species and subspecies develop an elaborate epidermal pattern in the adult.

The position is complicated by the fact that most of the group (B) species and subspecies assume several transitional forms in the development of the epidermal pattern, due to wear and age. There is an initial

more or less unicoloured delicately axially costate stage followed by loss of part, or of all of the ribbing, accompanied by, or followed by a differential loosening of the adhesion of the epidermis, which results in varied and often quite complicated patterns. With increasing age and exposure the epidermis lifts more and more until the appearance is uniformly pale, a condition found in many empty shells.

The form of the pattern seems to be rather haphazard, having no significance other than a tendency towards predominance of axial streaks in *turriculata* and *egca* and zigzags, chevrons and tessellations in *tessellata* and *aupouria*.

The epidermal patterns in *Liarea* seem to be paralleled in the Philippine genera of the helicoid group centred around *Helicostyla* and in cyclophorids from the same region.

Concerning these Philippine shells, Pilsbry (1894), described the surface as "covered with a thin transparent cuticle, often porous, when it becomes white and opaque, producing the 'hydrophanous' pattern which ornaments most species."

Why the epidermal patterns should assume such complicated and regular designs is not clearly understood, but it may be related to differential porosity in the formation of the shell.

The group (A) *carinella-hochstetteri* series and the group (B) *turriculata-egca* series frequently occur at the same locality, but they invariably occupy different ecological stations, the former tending towards a hydrophile and the latter towards a xerophile.

Group (A) favours the damp gullies and recesses of the forest, especially amongst rotting masses of nikau palm debris, but Group (B) occupies the better drained slopes and ridges of the forest floor, and is found most frequently under fallen leaves and around clumps of *Carex*.

That the "hydrophanous" pattern develops or is accentuated by alternations of wetting and drying is suggested by the fact that forms of group (B) from the perhumid areas such as Waipoua Forest, Broadwood, and elevated areas of Great Barrier Island show the absence of or only a slight tendency towards patterning. That climate has an influence upon shell size is indicated by the general tendency towards the distribution of small sized species at and south of Auckland and increasing size north of there, with the maximum sized form in the extreme north.

The *egca* series in particular exhibits a spectacular cline or probably more explicitly a geocline of the usage of Huxley (1939). That is, quantitative gradation based upon topographic or spatial separation. In text figure 3 the interruptions to the obvious cline are represented by two size breaks, one coincident with the long sandy isthmus, probably long devoid of suitable forest cover, which joins Awanui with the Cape Maria van Diemen-North Cape block, and the other, now less effective, coincident with the Auckland Isthmus and north of there.

In this latter instance former extensive volcanism may have caused a lengthy period of unsuitable conditions, temporarily segregating southern typical *egca* from its now larger northern counterpart.

The distributional map for the *egca* series (Text fig. 1A) also suggests that typical *egca* reached Great Barrier, Little Barrier and

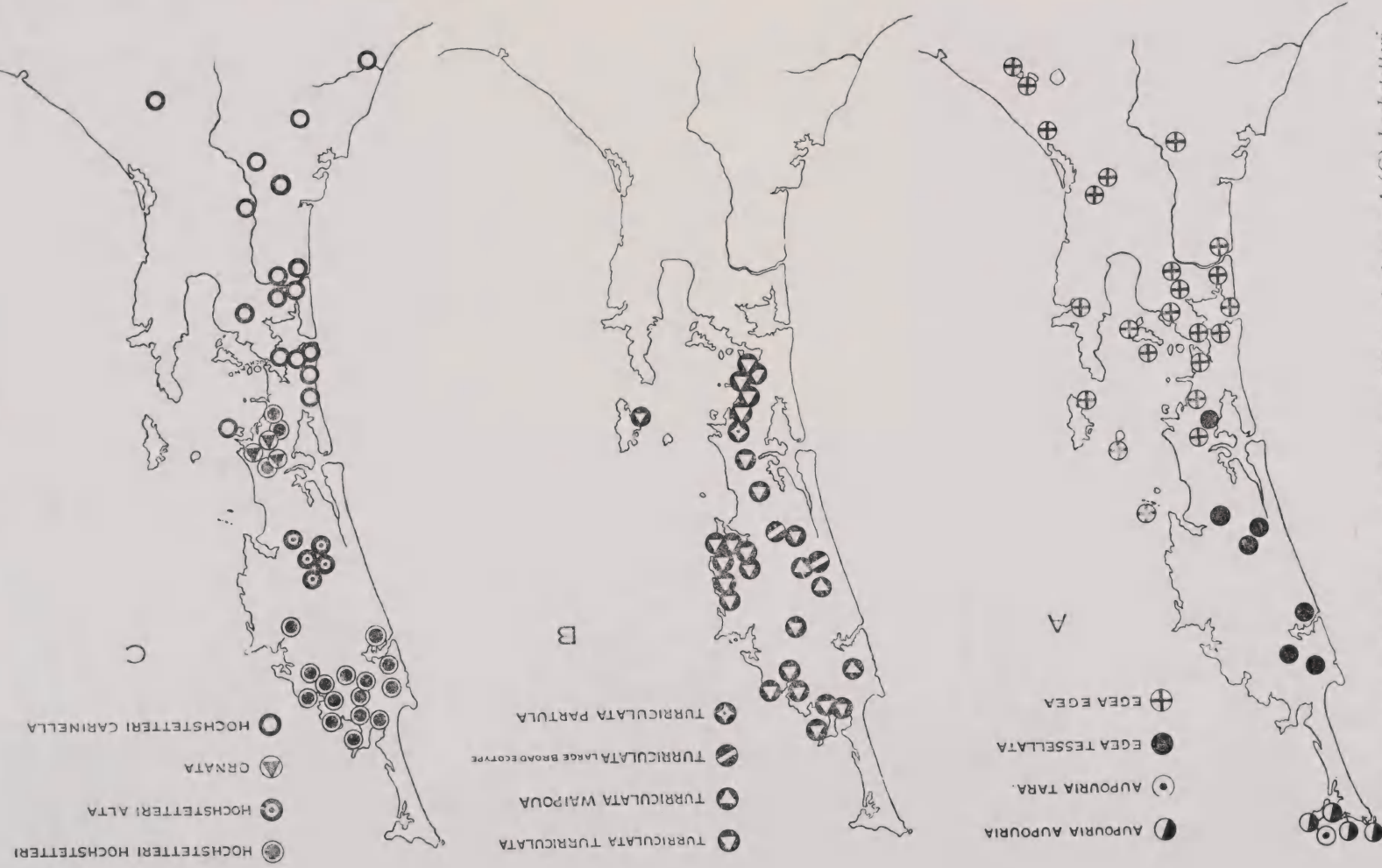


Fig. 1. Distributional patterns in (A) *egca*, (B) *turriculata*, and (C) *hochstetteri* series.

Chicken Islands by the Coromandel route, not necessarily a continuous land connection, whilst the assumed Auckland Isthmus volcanic phase allowed the development in temporary isolation of a larger sized counterpart of *egae* north of Auckland.

In *turriculata* there seems to be no genuine subspeciation, but a tendency towards larger size in localities where optimum conditions of a more luxuriant leaf mould prevail, i.e., slopes of Manaia, Waro and Whangarei. West of Whangarei a large more capacious whorled form occurs in or adjacent to elevated perhumid areas. These may be more correctly evaluated as ecotypes.

It was noted that the small typical form of *turriculata*, 7 mm. to 9 mm. in height, was invariably found where there was little accumulation of leaf mould.

In general, land snails develop more heavily calcified shells wherever there is an abundant source of lime, but in the case of *Liarea turriculata*, the distributional area for which is spread over a number of rock formations, including limestone, there is no apparent difference in size or weight of shell that could be correlated with the nature of the soil.

The *carinella-hochstetteri* series exhibit a clinal pattern also, with the small sized *carinella* distributed at and south of Auckland and the larger *hochstetteri* to the north of Auckland.

This series does not reach the far northern block and its largest member is not found in the far north but in and adjacent to the perhumid areas west and south-west of Whangarei. Ecotypes follow the pattern of an exaggerated spread of the flanged peristome in perhumid areas irrespective of geographic considerations.

Garnier (1950, 1951) has given very useful summaries of the New Zealand climate, but the paucity of stations relevant to Northland does not permit a close correlation between the snail occurrences and the climatic factors. From his map of North Island moisture types (1951, p. 89) two types only are involved in the *Liarea* distribution, the perhumid and the humid.

There is an indication, however, that the scale of winter temperatures may be a limiting factor in the distributional patterns. The summer temperatures for the whole area involved, apart from high altitude perhumid areas, are more uniform and are less likely to present a critical distributional factor.

The furthest south occurrence of the genus is in *lepida* Suter, considered by its author to be a subspecies of *turriculata*. Its relationship, however, is nearer to *egae*, but it is distinctive enough to warrant specific status.

This species occupies a relatively small distributional area extending from the vicinity of Masterton to Ormondville and Mauriceville, and thence westward through the Manawatu Gorge to the Horowhenua coastal plain.

It is separated from the distributional areas of the northern members of the genus by the central plateau and apparently the country extending westward to the vicinity of the Awakino River, Taranaki.

The Taupo pumice showers and other volcanic disturbances associated with the Central Plateau may be one of the causes of discontinuity in the *Liarea* distributional patterns in the southern part of the range. Climatic influences would count also, since the evidently critical winter low temperatures associated with the central higher altitude perhumid areas would be a decidedly limiting factor in respect to the reoccupation of areas that were formerly devastated by the pumice showers.

The genus *Liarea* is comparable with certain New Zealand fresh-water molluscan genera such as *Potamopyrgus*, *Isidora* and *Hyridella*, all of which are evidently plastic and are undergoing rather rapid responses to a series of changing environmental influences.

The close similarity in the dentition of the species of *Liarea* so far examined shows that the external differences do not as yet reflect very significant morphological changes. The several forms which I evaluate subspecifically undoubtedly represent species in the making that only time will resolve.

Much of our former almost continuous forest cover is now broken up into innumerable small isolated patches, and so it is probable that this artificially induced isolating factor may accelerate subspeciation and speciation in the future.

The gathering of material for this paper has been spread over the past twenty years, and apart from the results of my own field work I have had the use of extensive material collected by Mr. Norman Gardner and the late Mr. A. C. O'Connor.

Although the material examined consists of 150 locality lots and is represented by over 3,000 specimens, the present survey must be considered merely a provisional outline.

The topography of Northland is so broken that further localised subspecies will almost certainly be discovered when a more evenly distributed series of stations is achieved and in particular when more of the high country is investigated.

ACKNOWLEDGMENTS.

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SYSTEMATIC KEY.

A. SUTURE MARGINED

(a) Labial flange wide

- Epidermal pattern present *ornata*
 Epidermal pattern absent
 Spire $1\frac{1}{2}$ - $1\frac{2}{3}$ height of aperture
 Adult size 6.3 mm.-8.7 mm. *h. carinella*
 Adult size 7.5 mm.-10.4 mm. *h. hochstetteri*
 Spire $2-2\frac{1}{2}$ height of aperture
 Adult size 8.6 mm.-12.9 mm. *h. aita*

B. SUTURE SIMPLE

(a) Labial flange subobsolete

- Epidermal pattern present
 Spire 2 height of aperture
 Adult size 9.1 mm.-10.0 mm. *a. tara*

(b) Labial flange narrow

- Epidermal pattern present
 Spire $1\frac{1}{2}$ to $1\frac{2}{3}$ height of aperture
 Adult size 5.8 mm.-8.6 mm.
 Epidermal pattern bold axial streaks *e. egea*
 Spire 2 to $2\frac{1}{4}$ height of aperture
 Adult size 7.2 mm.-17.7 mm.
 Epidermal pattern bold axial streaks
 Spire narrowly tapered *t. turriculata*
 Epidermal pattern zigzags and tessellations
 Spire bluntly conical *e. tessellata*
 Adult size 9.8 mm.-13.20 mm.
 Epidermal pattern streaks and chevrons
 Spire broadly and bluntly conical *a. aupaouia*
 Epidermal pattern absent
 Spire 2 height of aperture
 Adult size 7.6 mm.-10.30 mm. *t. waipoua*

(c) Labial flange wide

- Epidermal pattern present
 Spire 2 height of aperture
 Adult size 6.3 mm.-7.9 mm. *lepida*
 Epidermal pattern absent
 Spire $1\frac{1}{2}$ to $1\frac{1}{3}$ height of aperture
 Adult size 7.0 mm.-8.2 mm. *t. partula*

LOCALITY KEY.

A. Cape Maria van Diemen-North Cape block	<i>a. aoupouria</i>
Kerr Point near North Cape only	<i>a. tara</i>
B. Northland Peninsula (south of Awanui)	
Mainly east coast	<i>t. turriculata</i>
West coast perhumid areas	<i>t. waipoua</i>
West and central areas south to Woodcocks	<i>c. tessellata</i>
West to east in north mainly east to Auckland	<i>h. hochstetteri</i>
West and south, vicinity of Whangarei	<i>h. alta</i>
Wellsford-Leigh-Omahua	<i>ornata</i>
South of Warkworth	<i>t. partula</i>
C. East Coast Islands	
Chickens and Little Barrier Islands	<i>e. egea</i>
Great Barrier Island	<i>e. egea</i> and <i>t. turriculata</i>
Kawau Island	<i>h. carinella</i>
Waiheke Island	<i>e. egea</i>
D. Auckland Isthmus	
Mainly east coast	<i>e. egea</i>
Mainly west coast	<i>h. carinella</i>
E. South of Auckland	
Mainly western to Awakino	<i>h. carinella</i>
Mainly central and eastern to Te Puke and Rotorua	<i>e. egea</i>
F. Wellington	
Wairarapa-Manawatu-Horowhenua	<i>lepida</i>

See text figure 1 for maps showing detailed plotting of stations:
A. *egea*, B. *turriculata*, C. *hochstetteri* series.

A. THE HOCHSTETTERI SERIES.

The distinguishing features of the *hochstetteri* series are the margined suture, the more or less uniform coloration without "hydrophanous" patterns (except in *ornata* n. sp.), the strongly carinated body-whorl and the flat, broadly expanded, concentrically striated flange-like lip, encircling the inner, narrow, slightly raised peristome.

The known geographic range of the *hochstetteri* series is from Awanui in Northland to Awakino in Northern Taranaki.

The *hochstetteri*, *alta* and *carinella* subspecies favour the more or less constantly moist locations in the forest, and are most frequently found clinging to rotting fallen leaf sheaths of the nikau palm. Since these snails are thus not subject to extremes of alternate wetting and drying, as is the case with the *turriculata-egea* series, which favour drier situations, this may be the factor that determines the presence or absence, or the degree of development, of a hydrophanous pattern.

It is significant that the habitat of *ornata*, the only member of the *hochstetteri* series to develop the hydrophanous pattern, is in relatively dry, well drained situations, and conversely that the *turriculata* ecotypes from perhumid or verging upon perhumid locations show only slight tendencies towards epidermal patterning.

Another variation in the *hochstetteri* series that may be considered ecotypic rather than subspecific is in the relative expanse of the outer-lip flange, which is narrow in populations from the relatively dry coastal areas of the vicinity of Mangonui and Bay of Islands and very wide in the perhumid western areas. The maximum development of this feature is shown in examples from Herekino Gorge.

The physical function of the expanded outer-lip flange may be to assist the animal's ability to cling to the soft, slimy surface of decaying vegetation by operating as a suction disc, and it may also serve as a copulatory aid.

The only sinistral example of the genus known to me is a specimen of *hochstetteri* typical, in my collection, from Oretere Bush, near Kaeo.

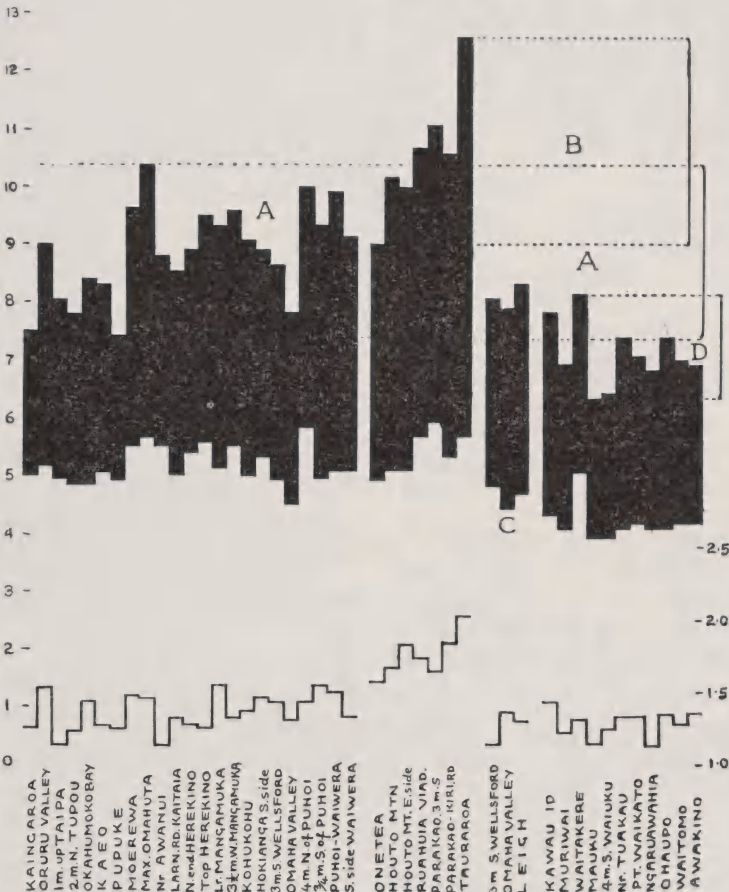


Fig. 2. Histogram of populations for *Liarea hochstetteri* series. Columns represent an average of at least ten adult specimens for each locality (see left-hand scale in mm.). Top of column represents height averages and bottom of column width averages. Stepped line below plots the spire height index (see right-hand scale in mm.). A = *hochstetteri hochstetteri*. B = *hochstetteri alta*. C = *ornata*. D = *hochstetteri carinella*.

***Liarea hochstetteri hochstetteri* (L. Pfeiffer). Pl. 44, fig. 6;
Pl. 45, figs. 9-12.**1861—*Realia hochstetteri* Pfeiffer, Malak. Bl. 8, p. 149.1865—*Realia hochstetteri*: Pfeiffer, Monog. Pneumonopomorum Viventium,
2nd suppl., p. 170.1913—*Realia hochstetteri*: Suter, Manual N.Z. Mollusca, p. 196, Pl. 38, fig. 32.

Shell of moderate size, 7.5 mm. to 10.4 mm. in height with broadly conical spire and a strongly angled to keeled body-whorl. Whorls 7 to $7\frac{1}{2}$, including a depressed globose protoconch of two smooth whorls. Spire-whorls, lightly convex, rapidly and regularly increasing. Suture supra-margined with a narrow rounded sharply raised cord. Spire one and a-half to one and two-third height of aperture. Spire height index (i.e., body-whorl width into spire height), 1.12 to 1.56 with an average of 1.36. Sculpture consisting of closely spaced retractive narrow axial plications. Aperture ovate-rotund, slightly oblique, subangled above. Peristome with a slightly raised inner rim, surrounded by a broadly expanded concentrically striated thin flange. Perforation open, rather broadly crescentic, margined by a rounded cord. Colour ranging from uniformly dark horny to sepia.

Type: Bay of Islands (Hochstetter) K. K. Hofmuseum, Vienna. "Long. 9, diam. 4 mill."

The dimensions given by Pfeiffer indicate either an abnormally narrow shell or more likely a basis of measurement different from the one adopted in this paper. My method gives the diameter as the maximum distance from the point of greatest diameter of the body-whorl on the left to the point of greatest convexity of the outer lip flange on the right, measured at right angles to the vertical axis of the shell.

Typical *hochstetteri* occurs only in Northland, where it occupies a block extending from coast to coast south of Awanui to Hokianga on the West Coast and Bay of Islands on the east coast. It extends southwards through the inland country between Whangarei and towards the west coast, where it is represented by the taller-spined *hochstetteri alta* n. subsp. (described following) and reaches its apparently southern limit, again approximating the typical subspecies, in the east coast area from Wellsford to Waiwera.

The latter present a rather different appearance by having the plications standing out as white threads on a shining dark-horny to sepia ground colour.

Further inland collecting stations between Kawakawa and south of Whangarei are required to determine if there is a continuity between the northern and southern typical *hochstetteri* populations, irrespective of the tall-spined *hochstetteri alta*, which is sandwiched between, but more to the westward. Suter recorded *hochstetteri* from Whangarei Heads, but I have not been able to substantiate this record in the field.

Locality	Smallest*	Largest	Average	Spire Ht. Index
Kaingaroa	7.10 x 4.80	7.80 x 5.20	7.5 x 5.0	1.25
Oruru Valley, Mangonui	8.10 x 5.10	9.90 x 5.40	9.0 x 5.2	1.53
One mile up Taipa	7.80 x 4.90	8.50 x 5.20	8.1 x 4.9	1.26
Two miles West of Tupou	7.10 x 4.70	8.20 x 5.00	7.7 x 4.8	1.22
Okahumoko Bay	8.25 x 4.80	8.60 x 4.90	8.4 x 4.8	1.43

Locality	Smallest*	Largest	Average	Spire Ht. Index
Kaeo	8.20 x 4.80	8.60 x 5.30	8.3 x 5.1	1.28
Pupuke	7.20 x 4.90	7.70 x 4.90	7.4 x 4.9	1.25
Three miles S. of Moerewa	—	9.70 x 5.50	—	1.49
Maxwell's, Omahuta	10.10 x 6.00	10.80 x 5.80	10.4 x 5.7	1.47
Near Awanui	8.50 x 5.70	9.20 x 5.50	8.8 x 5.5	1.12
Larner's Road, Kaitaia	8.20 x 4.80	9.10 x 5.10	8.6 x 5.0	1.32
North entr. Herekino Gorge	8.10 x 5.10	9.80 x 5.80	8.9 x 5.4	1.28
Top of Herekino Gorge	9.20 x 5.80	9.90 x 5.50	9.5 x 5.6	1.25
Lower Mangamuka Gorge	8.60 x 5.30	9.80 x 5.20	9.3 x 5.2	1.56
3½ m. W. of Mangamuka	9.10 x 5.10	10.00 x 5.50	9.6 x 5.5	1.32
Kohukohu, Hokianga	9.30 x 5.10	9.20 x 5.00	9.1 x 5.0	1.38
Hokianga, South side	8.60 x 5.50	9.10 x 5.10	8.9 x 5.3	1.46
Three miles S. of Wellsford	8.50 x 4.90	8.90 x 5.00	8.7 x 4.9	1.42
Omaha Valley	7.60 x 4.30	8.10 x 4.70	7.8 x 4.5	1.30
Four miles North of Puhoi	9.20 x 5.50	10.60 x 6.00	10.0 x 5.8	1.42
¼ mile South of Puhoi	8.80 x 5.00	9.80 x 5.00	9.3 x 4.9	1.54
Puhoi-Waiwera	9.60 x 5.20	10.00 x 5.00	9.9 x 5.1	1.50
South side of Waiwera	8.80 x 5.00	10.10 x 5.30	9.2 x 5.1	1.32
Average of combined averages of above lots:			8.8 x 5.1	1.36

* Smallest sized example with adult labial features.

Dentition: Pl. 48, fig. 39. Kaeo, Northland.

Localities: Kaingaroa, between Awanui and Mangonui (A. E. Brookes, 1917); Oruru Valley, near Mangonui (A.W.B.P. coll.); one mile up south side of Taipa Estuary (A.W.B.P., 20/1/1950); Oruaiti Bush, Northland (N. Gardner, August, 1950); two miles west of Tupou Bay, east of Mangonui (Map N. 7, Ref. 144884) (A.W.B.P., 20/6/1947); Okahumoko Bay, Whangaroa (Mrs. I. Worthy, 1948); Oreteri Bush, near Kaeo (Mrs. I. Worthy); Pupuke, near Whangaroa (Mrs. I. Worthy); Bay of Islands (type) (Hochstetter); three miles south of Moerewa (N. Gardner); Maxwell's Farm, Omahuta, five miles south of Mangamuka Bridge (A. Hancox, 1948); near Awanui (W. La Roche); Quarry, Larner's Road, Kaitaia (N. Gardner, December, 1947); northern entrance to Herekino Gorge (A.W.B.P., 31/1/1950); Manukau North, near Herekino (N. Gardner, 2/1/1950); Top of Herekino Gorge (Mrs. I. Worthy); Mangamuka Gorge, south entrance (A.W.B.P., January, 1948); Mangamuka Bridge to Tutekehua, Lower Mangamuka Gorge (A. Hancox, 1948); 3½ miles west of Mangamuka Gorge (Mrs. I. Worthy); Hick's Bush, near Kohukohu-Broadwood Road Junction (A. E. Brookes); Kohukohu, Hokianga; Hokianga River, south side (W. La Roche); six miles south of Warkworth (K. Hipkins); three miles south of Wellsford (N. Gardner, 27/3/1948); Omaha Valley, near Matakana (N. Gardner, 25/3/1948); four miles north of Puhoi (N. Gardner, 28/3/1948); three-quarter of a mile south of Puhoi (N. Gardner, 29/3/1948); half a mile south of Waiwera (N. Gardner, October, 1947); north side of Waiwera-Puhoi hill (Map N. 38, 202990, ca. 300ft.) (A.W.B.P., April, 1947).

Liarea hochstetteri alta n. subsp. Pl. 45, figs. 13 and 14.

Shell relatively large with narrowly conical spire and weakly carinated body-whorl. Whorls 9, including a depressed globose protoconch of 2 smooth whorls. Spire whorls lightly convex, gradually increasing to the eighth, the ninth very little wider. Suture supra-margined with a narrow rounded sharply raised cord. Spire twice to two and a half times height of aperture. Spire height index (i.e., body-whorl width into spire height) 1.58 to 2.14 with an average of 1.77. Sculpture consisting of closely-spaced retractive narrow axial plications. Aperture ovate-rotund, slightly oblique, subangled above. Peristome with a slightly raised narrow inner rim, surrounded by a broadly expanded concentrically striated flange. Perforation narrow, crescentic, margined by a rounded cord. Colour dark sepia.

Holotype: Between Tauraroa and Waioitira. Auckland Museum. Height 12.75 mm.; diameter 5.60 mm.

Locality	Smallest	Largest	Average	Spire Ht. Index
Onetea, Northern Wairoa	9.00 x 5.00	9.10 x 4.90	9.0 x 4.9	1.58
Houto Mountain (pale)	9.20 x 5.00	11.20 x 5.10	10.2 x 5.1	1.67
East slope, Houto Mountain	8.60 x 4.90	11.20 x 5.20	10.0 x 5.1	1.82
Ruahua Viaduct	9.80 x 5.60	11.40 x 5.70	10.7 x 5.7	1.73
Three miles S. of Parakao	10.90 x 6.00	11.20 x 5.80	11.1 x 5.9	1.63
Parakao-Kirikopuni	9.70 x 5.20	11.60 x 5.50	10.6 x 5.3	1.83
Tauraroa-Waioitira	12.3 x 5.60	12.90 x 5.90	12.6 x 5.7	2.14
Average of combined averages of above lots:			10.6 x 5.4	1.77

The subspecies *alta* is larger than typical *hochstetteri* and has a relatively much taller spire. The peristome is broadly expanded as in the ecotype from Herekino and other western perhumid areas. Examples from Onetea, Northern Wairoa, and the western slopes of Houto Mountain are pale to dark horny.

Localities: Between Tauraroa and Waioitira, west side of railway track (A.W.B.F., 27/3/1949) (Map N. 24, Ref. 725750, 250-300ft.) (Holotype); Ruahua Viaduct, Parakao-Kirikopuni Road, Mangakahia District (Map N. 19, Ref. 477941, ca. 500ft.) (A.W.B.P., 28/10/1947); three miles south of Parakao, Mangakahia District (N. Gardner, October, 1947); Parakao-Kirikopuni Road, Mangakahia District, foot of western slope of Houto Mountain (Map, Dargaville, N. 23, Ref. 480897, 200-250ft.) (A.W.B.P., 28/10/1947); Onetea, Northern Wairoa.

***Liarea hochstetteri carinella* (L. Pfeiffer). Pl. 44, fig. 7; Pl. 45, fig. 15.**

1861—*Realia carinella* Pfeiffer, Malak. Bl. 8, p. 150.

1865—*Realia carinella*: Pfeiffer, Monog. Pneumonoporum Viventium, 2nd suppl. p. 170.

1913—*Realia carinella*: Suter, Manual N.Z. Mollusca, p. 195, Pl. 38, fig. 30.

Shell small, 6.3 mm. to 8.7 mm. in height, with narrowly conical spire and a very sharply angled and keeled body-whorl. Whorls 7, including a depressed globose protoconch of 2 smooth whorls. Spire whorls lightly convex, regularly increasing, the whole outline of the spire straight, to slightly concave between the protoconch and the second to third post-nuclear whorls. Spire one and a-half to one and two-thirds height of aperture. Spire height index (i.e., body-whorl width into spire height) 1.16 to 1.42, with an average of 1.29. Suture supra-margined with a narrow rounded sharply raised cord. Sculpture consisting of closely spaced retractive narrow weak axial threads which become subobsolete over the base. Aperture vertical, ovate-rotund, subangled above. Peristome with a slightly raised inner rim, surrounded by a broadly expanded concentrically striated thin flange. Perforation open, narrowly crescentic, margined by a rounded cord. Colour light brown, or warm dark-brown.

Type: Drury and Taupiri (Hochstetter). K. K. Hofmuseum, Vienna. "Long. 7, diam. $3\frac{1}{4}$ mill."

Again the dimensions given by Pfeiffer indicate that the width is understated. A sight measurement based upon the greatest width, taken at right angles to the axis of the shell, shows 4.10 mm. for a shell 7 mm. in height.

Although the extremes appear recognisably distinct, the differences between *hochstetteri hochstetteri* and *hochstetteri carinella* are not very

marked when large series from numerous localities are considered. The former ranges the larger (8.8 mm. x 5.1 mm. average) with capacious whorls and the latter the smaller (7.1 mm. x 4.2 mm. average) with a narrower spire and less capacious whorls. Also, the axials tend towards obsolescence on the base only in *carinella*, but not invariably so. The spire height index shows a similar range of variation in both subspecies.

The histogram (Text fig. 2) shows clearly the constantly smaller size range of the Auckland and south of Auckland *carinella* subspecies. See also the map (Text fig. 1C.), which shows the *carinella* distributional area from the northern end of the Waitakere Range to Awakino; all western drainage except for an isolated eastern location at Kawau Island.

Locality	Smallest	Largest	Average	Spire Ht. Index
Waitakere Range	7.60 x 4.70	8.70 x 5.50	8.2 x 5.1	1.30
Muriwai	6.80 x 4.00	7.00 x 4.10	6.9 x 4.1	1.21
Kawau Island	7.60 x 4.20	7.90 x 4.40	7.8 x 4.3	1.42
Mauku	5.90 x 3.70	6.80 x 4.20	6.3 x 3.9	1.26
Four miles South of Waiuku	6.00 x 4.00	6.80 x 4.00	6.4 x 3.9	1.23
Near Tuakau	7.00 x 4.00	7.80 x 4.20	7.4 x 4.1	1.32
Port Waikato	6.50 x 4.10	7.50 x 4.20	7.1 x 4.2	1.32
Ngaruawahia	6.70 x 4.20	6.90 x 4.10	6.8 x 4.1	1.16
Ohaupo	7.10 x 4.00	7.50 x 4.20	7.4 x 4.1	1.32
Waitomo Caves	6.10 x 3.80	7.50 x 4.40	7.0 x 4.2	1.29
Awakino Gorge	6.40 x 3.90	7.50 x 4.50	6.9 x 4.2	1.36
Average of combined averages of above lots:			7.1 x 4.2	1.29

Localities: Above School House Bay, Kawau Island (A.W.B.P., July, 1949); Muriwai, West Coast, Auckland (A.W.B.P.); Swanson, Waitakere Range (H. Suter coll.); Pukematakeo, Waitakere Range (Map N. 41, Ref. 063566, 1104.t.) (N. Gardner, 15/1/1948); Huia, Manukau (N. Gardner, 1947); Titirangi, Auckland (N. Gardner, October, 1946); Mt. Wellington lava fields, Auckland (A. Suter); four miles south of Waiuku (A.W.B.P., 1927); Mauku, Pukekohe (N. Gardner, October, 1947); Maketu, Hunua Range (H. Suter coll.); near Tuakau (A.W.B.P., March, 1946); Port Waikato (W. La Roche); Hill behind Ngaruawahia (N. Gardner, 7/1/1949); Ohaupo, Waikato (H. Suter Coll.); Mt. Pirongia (A. E. Brookes); Tarukenga, Rotorua (H. Suter coll.); Entrance to Waitomo Caves (A.W.B.P., February, 1949); Awakino Gorge (A.W.B.P., 1926).

Liarea ornata n. sp. Pl. 48, fig. 37.

Shell small, 8.4 to 8.7 mm. in height with conical, straightsided whorls and subangled to keeled body-whorl. Whorls $6\frac{1}{2}$ to 7, including a depressed globose protoconch of two smooth whorls. Spire-whorls almost flat in outline, regularly increasing. Suture prominently supra-margined with a rounded sharply raised cord. Spire one and a-half times height of aperture. Spire height index (i.e., body-whorl width into spire height) 1.28 to 1.36 with an average of 1.31. Surface smooth and polished, with subobsolete closely to irregularly spaced axial growth lines. Base rounded, smooth, with a deep broadly crescentic umbilicus margined by a rounded cord. Aperture ovate-rotund, oblique and subangled above. Peristome with a slightly raised narrow inner rim, surrounded by a moderately wide concentrically striated thin flange. Colour dark reddish-brown with a conspicuous hydrophanous pattern in pale buff in the form of elaborate chevrons. The base is uniformly dark brown, the umbilical cavity and outer lip flange pale brown.

Holotype: Three miles south of Wellsford. Auckland Museum. Height, 8.4 mm; diameter 5.0 mm.

Locality	Smallest	Largest	Average	Spire Ht. Index
Three miles S. of Wellsford	7.90 x 4.40	8.40 x 5.00	8.1 x 4.8	1.28
Omaha Valley	7.40 x 4.40	8.50 x 4.50	7.9 x 4.4	1.36
Leigh	7.80 x 4.40	8.70 x 5.00	8.3 x 4.7	1.30
Average of combined averages of above lots:			8.1 x 4.6	1.31

This species is the only one of the *hochstetteri* series to exhibit the hydrophanous pattern so characteristic of the *egea-turriculata* series. That it belongs to the *hochstetteri* series and not to the latter is clearly shown by the margined suture, rim-margined umbilicus and expanded outer lip flange.

It occupies a compact block of territory extending from the vicinity of Warkworth to Leigh and Omaha.

Typical *hochstetteri* occurs in association with *ornata* at one locality, Warkworth, but no intergradation is evident.

An original hybrid origin is suspected for *ornata*, which now seems to have acquired genetical isolation, and if this is so hybridism must have occurred in the past when the *hochstetteri* and the *egea-turriculata* series were less strongly differentiated than they are at present. Certainly under present circumstances elsewhere, in locations where both series occur more or less together, there is no sign of hybrid influences.

Localities: Three miles south of Wellsford in reserve near bridge, main highway (Map N. 33, Ref. 072233, 200ft.) (N. Gardner and A.W.B.P., January, 1952) (*Holotype*); Omaha Valley, Matakana (N. Gardner, 28/3/1948); Leigh (Map N. 34, Ref. 290322, 30-50ft.) (A.W.B.P., 26/2/1948).

B. THE EGEA-TURRICULATA SERIES.

The distinguishing features of the *egea-turriculata* series are the simple unmarginated suture, the well developed hydrophanous epidermal pattern, the rounded body-whorl, subangled at most, the relatively narrow labial flange and the small to vestigial umbilical cavity.

The known geographical range of the *egea-turriculata* series is from the northernmost tip of Northland to the Horowhenua Plain north of Wellington. South of Auckland the series extends to the Waikato and eastwards to Rotorua, but is absent from the remaining southern and eastern areas of the North Island, apart from *lepida* which occupies a compact area from the Wairarapa, the Manawatu and the Horowhenua Plain.

The species *turriculata* is restricted to the Northland Peninsula to as far north as Kaingaroa, near Awapuni. Its preference is for the warmer and drier eastern areas, but a presumed subspecies of slightly broader proportions with an obsolete or less prominently developed hydrophanous pattern, occupies sporadically, perhumid and verging upon perhumid locations, mostly in central areas, to the westward or in high country.

The *egea* series exhibit a spectacular geocline with an increasing size range from south to north, as already explained in the introduction, and is graphically shown in the histogram (Text fig. 3).

***Liarea egea egea* (Gray). Pl. 44, fig. 4; Pl. 47, figs. 27-32.**1850—*Realia egea* Gray, Proc. Zool. Soc. (Lond.) for 1849, p. 167.1852—*Realia egea*: Pfeiffer, Monog. Pneumoporum Viventium, p. 305.1913—*Realia egea*: Suter, Manual N.Z. Mollusca, p. 196, Pl. 38, fig. 31.

Shell small, 5.8 mm. to 8.6 mm. in height with broadly conical spire, whorl outlines strongly convex with body-whorl rounded to weakly sub-angled. Whorls 6 to 6½, including a small papillate protoconch of two smooth whorls. Suture simple. Spire one and a-half to one and two-thirds height of aperture. Spire height index (i.e., body-whorl width into spire height) 1.13 to 1.58 with an average of 1.35. Umbilicus small to moderate, crescentic and often margined with a weak cord. Aperture ovate to oblique D-shaped. Peristome narrow, slightly raised and surrounded by a moderate to relatively narrow thin flange. Sculpture in well preserved examples consists of numerous narrow membranous axials which rapidly wear down and leave faint narrow axial thread-like folds on an otherwise smooth surface. The initial colour pattern is a broad basal spiral band on a uniform ground colour of light to dark brown. After the wearing down of the axials the hydrophanous epidermal pattern develops on the spire and is usually a bold design of broad axial streaks, often flexuous but seldom chevroned to any extent.

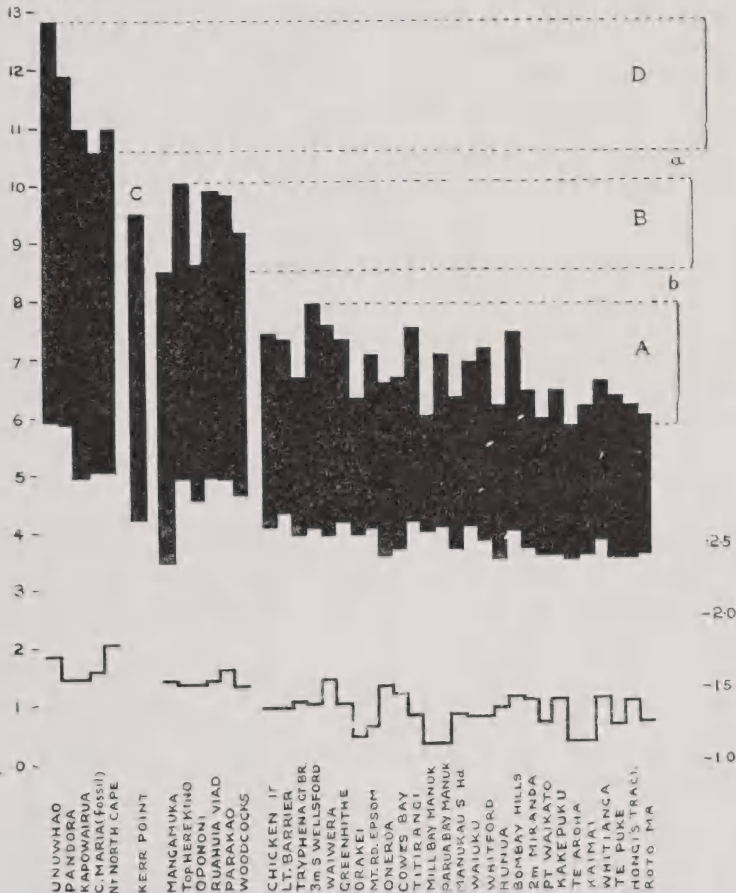


Fig. 3. Histogram of populations for *Liarea egea* series. A = *egea egea*. B = *egea tessellata*. C = *aupouria tara*. D = *aupouria aupouria*. Note the geocline with size gaps coincident with (a) the far northern sandy isthmus and (b) the east coast to the north of Auckland.

Type: Auckland (Greenwood), British Museum (Natural History). "Length 2½ lines" (Gray).

Locality	Smallest	Largest	Average	Spire Ht. Index
Chicken Island	6.75 x 3.80	8.00 x 4.25	7.4 x 4.1	1.38
Little Barrier Island	6.90 x 4.20	7.90 x 4.60	7.3 x 4.3	1.38
Tryphena, Great Barrier	6.20 x 3.90	7.00 x 4.00	6.7 x 3.9	1.42
Three miles S. of Wellsford	7.00 x 4.00	8.60 x 4.20	7.9 x 4.1	1.40
Waiwera	6.60 x 3.90	8.40 x 4.20	7.6 x 3.9	1.58
Greenhithe	6.70 x 4.10	8.00 x 4.30	7.3 x 4.2	1.40
Orakei, Auckland	5.90 x 4.00	6.90 x 4.00	6.3 x 3.9	1.18
Mt. Rd., Mt. Eden, Auck.	6.10 x 3.30	8.00 x 4.40	7.1 x 4.1	1.27
Oneroa, Waiheke Island	5.80 x 3.40	7.40 x 3.90	6.6 x 3.6	1.56
Cowes Bay, Waiheke	6.70 x 3.70	7.00 x 3.70	6.7 x 3.7	1.48
Whitford	6.80 x 3.50	7.30 x 4.00	7.2 x 3.8	1.32
Two miles W. of Miranda	6.10 x 3.70	7.00 x 3.80	6.4 x 3.7	1.42
Hunua	6.00 x 3.25	7.00 x 3.80	6.2 x 3.5	1.38
Bombay Hill	6.30 x 3.70	7.90 x 4.00	7.4 x 4.0	1.45
Te Aroha	5.60 x 3.50	6.00 x 3.50	5.8 x 3.5	1.28
McLaren's, Kaimai	5.60 x 3.30	6.40 x 3.50	6.2 x 3.6	1.26
Whitianga	5.80 x 3.60	7.10 x 4.10	6.6 x 3.8	1.44
Hongi's Track	5.70 x 3.30	6.60 x 3.80	6.2 x 3.5	1.42
Roto Ma, Rotorua	5.70 x 3.30	6.60 x 4.00	6.0 x 3.6	1.29
Te Puke	6.20 x 3.50	6.60 x 3.80	6.3 x 3.5	1.26
Mill Bay, Manukau	5.70 x 4.00	6.20 x 4.00	6.0 x 4.0	1.13
Titirangi Beach	7.30 x 4.50	7.90 x 4.10	7.5 x 4.2	1.32
Parua Bay, Manukau	6.90 x 3.90	7.40 x 4.10	7.1 x 4.1	1.13
Manukau South Head	6.00 x 3.50	7.30 x 4.00	6.3 x 3.7	1.33
Waiuku	6.40 x 4.00	7.10 x 4.20	6.7 x 4.1	1.32
Port Waikato	5.70 x 3.00	6.50 x 4.00	5.9 x 3.6	1.29
Average of combined averages of above lots:			6.7 x 3.9	1.35

Dentition: Pl. 48, fig. 38. Whitford, Auckland.

Localities: Chicken Islands (2nd island from east) (A.W.B.P., "Will Watch" Exped., February, 1934); Little Barrier Island (A. E. Brookes); Tryphena, Great Barrier Island (N. Gardner, January, 1951); Three miles south of Wellsford (N. Gardner); Waiwera (T. F. Cheeseman); Greenhithe (N. Gardner); Hillyer's Creek, Auckland (A.W.B.P., 25/4/1927); Orakei Bush, Auckland (A.W.B.P.); Mountain Road, Mt. Eden, Auckland (N. Gardner); Mt. Wellington lava fields, Auckland (W. La Roche); Between Oneroa and Palm Beach, Waiheke Island (A.W.B.P., January, 1933); Onetangi, Waiheke Island (N. Gardner, 21/2/1948); Cowes Bay, Waiheke Island (W. La Roche); Four miles south of Howick, Auckland (A.W.B.P., 4/6/1927); Whitford (N. Gardner, 5/6/1948); Hunua Falls (N. Gardner, August, 1947); Hunua Range (H. Suter coll.); Summit of Bombay Hill (N. Gardner, 7/1/1949); Two miles west of Miranda (Raines Rd.) (N. Gardner, 26/12/1948); Te Aroha (W. H. Webster); Whitianga (K. Hipkins, 1948); McLaren's Falls, Lower Kaimai (N. Gardner, 27/12/1948); Upper Kaituna River, Te Puke (N. Gardner, 27/12/1948); Two miles east of Roto Ma Lake, Rotorua (N. Gardner, 5/1/1949); Hongi's Track, Rotorua (N. Gardner, 5/1/1949); Titirangi Beach (N. Gardner, November, 1947); Mill Bay, Manukau Harbour (N. Gardner, December, 1947); French Bay, Manukau Harbour, in Manuka scrub (N. Gardner); Waikowhai Bush, Manukau Harbour (D. H. Graham); Cornwallis, Manukau (A.W.B.P.); Manukau South Head (W. La Roche); Parua Bay, Manukau (N. Gardner, December, 1947); Mauku, near Patumahoe (N. Gardner, October, 1947); Waiuku (W. H. Webster); Tuakau (H. Suter coll.); Port Waikato (W. La Roche); Mt. Kakepuka, near Te Awamutu (N. Gardner, 7/4/1947).

The typical subspecies is found around Auckland, south of there to the Waikato and eastwards to Rotorua. Northwards it extends sporadically to Wellsford and to the islands of Little Barrier, Great Barrier, and the Chickens. North of Wellsford to Hokianga and Herekino a larger subspecies (described following) is distributed, and this exhibits a complex chevroned to tessellated hydrophanous pattern.

***Liarea egea tessellata* n. subsp. Pl. 44, fig. 5; Pl. 47, figs. 24-26.**

Shell of moderate size, 8.6 mm. to 11.0 mm. in height with tall conical spire. Whorl outlines strongly convex, with body-whorl rounded to weakly subangled. Whorls $6\frac{1}{2}$ to 7, including a small papillate protoconch of two smooth whorls. Suture simple, deeply impressed. Spire twice height of aperture. Spire height index (i.e., body-whorl width into spire height) 1.40 to 1.64 with an average of 1.54. Umbilicus moderate, broadly crescentic, margined by a weak cord. Aperture ovate-rotund, only slightly subangled above. Peristome narrow, slightly raised and surrounded by a narrow thin flange. Sculpture consisting of numerous weak axial threads which rapidly wear off, leaving the surface smooth. Hydrophanous epidermal pattern a striking complicated alternation of dark reddish-brown and buff in the form of axial streaks, zigzags and chevrons, often resulting in tessellation. Base uniformly dark or with a broad dark band on the upper part of the base only.

Holotype: Opononi, Hokianga. Height 8.7 mm.; diameter 4.5 mm. Auckland Museum.

Locality	Smallest	Largest	Average	Spire Ht. Index.
$3\frac{1}{2}$ miles W. of Mangamuka	7.90 x 4.20	9.00 x 4.50	8.5 x 4.4	1.57
Top of Herekino	9.20 x 4.50	11.00 x 5.30	10.1 x 4.9	1.54
Opononi	8.00 x 4.70	9.40 x 4.90	8.7 x 4.6	1.54
Owhatu, Herekino	8.20 x 4.70	10.30 x 4.70	9.5 x 4.6	1.48
Two miles W. Tangowahine	8.60 x 4.20	10.60 x 5.00	9.6 x 4.7	
Ruahua Viaduct	9.50 x 4.80	10.00 x 4.90	9.8 x 4.9	1.57
$1\frac{1}{4}$ miles East of Parakao	9.30 x 4.90	10.10 x 5.00	9.8 x 4.9	1.64
Three miles S. of Wellsford	7.00 x 4.00	8.60 x 4.20	8.0 x 4.1	1.40
Woodcocks	8.00 x 4.50	10.20 x 4.80	9.2 x 4.7	1.52
Average of combined averages of above lots:			9.2 x 4.6	1.53

The subspecies *tessellata* is not only larger than *egea* typical with half to one more whorl, but it has a relatively taller spire and almost invariably a more complicated zigzag to tessellated pattern.

Its range is from Woodcocks to Herekino, Northland, over central and western areas of the peninsula, and it favours the warmer and drier, more open outskirts of the forest.

Localities: Top of Herekino Gorge (Mrs. I. Worthy); $3\frac{1}{2}$ miles west of Mangamuka Gorge, southern entrance (Mrs. I. Worthy); Opononi, Hokianga (W. La Roche) (type); Two miles west of Tangowahine, Dargaville District (Map No. 23, Ref. 427786) (A.W.B.P., 28/10/1947); Ruahua Viaduct, Parakao-Kirikopuni Road, Mangakahia District (Map N. 19, Ref. 477941) (A.W.B.P., 28/10/1947); $1\frac{1}{4}$ miles east of Parakao, north side of road, Mangakahia District (Map N. 19, Ref. 504986) (A.W.B.P., 25/10/1947); Three miles south of Wellsford (N. Gardner); Between Tauraroa and Waitotira, west side of railway track (A.W.B.P., 27/3/1949) (Map N. 24, Ref. 725750, 250-300ft.); Woodcocks (Map N. 33, Ref. 093086, ca. 550ft.) (A.W.B.P., 11/2/1948).

***Liarea aupouria aupouria* n. sp. Pl. 44, fig. 2; Pl. 48, figs. 33 and 33a.**

Shell largest for the genus, 9.80 mm. to 13.20 mm. in height. Tall-spired but broad in proportion. Whorl outlines moderate convex with body-whorl rounded and only occasionally weakly subangled. Whorls $7\frac{1}{2}$, including a blunt dome-shaped protoconch of two whorls followed by a half-whorl of closely spaced brephic axial threads. Suture simple, deeply impressed. Spire twice to two and a-quarter times height of aperture. Spire height index (i.e., bodywhorl width into spire height)

1.59 to 1.82 with an average of 1.67. Umbilicus small, crescentic, not margined. Aperture relatively large, oblique ovate to D-shaped, strongly subangled above. Peristome narrow, slightly raised and surrounded by a relatively narrow thin flange. Sculpture of rather closely spaced weak axial threads which rapidly wear off, leaving a smooth surface. Colour reddish-brown to dark sepia with a complex hydrophanous epidermal pattern in buff to pale yellowish brown. The pattern ranges from simple broad irregular axial streaks to complicated zigzags and chevrons. The base is mostly light brown with a broad diffused spiral band above, or the entire base may be dark brown.

Holotype: Unuwhao, 850-900ft. Height 13.20 mm.; diameter 6.0 mm. Auckland Museum.

Locality	Smallest	Largest	Average	Spire Ht. Index
Unuwhao	12.10 x 5.60	13.20 x 6.00	12.8 x 5.9	1.74
Pandora	10.80 x 5.60	12.80 x 6.00	11.9 x 5.8	1.59
Kapowairua	10.00 x 5.00	11.10 x 5.00	11.0 x 4.9	1.59
Cape Maria (fossil)	9.80 x 5.00	12.00 x 5.60	10.6 x 5.1	1.63
Near North Cape	11.00 x 5.00	11.70 x 5.10	11.0 x 5.1	1.82
Average of combined averages of above lots:			11.4 x 5.3	1.67

Localities: Cape Maria van Diemen (mainland) consolidated dunes, site of type locality for *Placostylus ambagiosus priscus* Powell (A.W.B.P.); Kahuronaki (Kahuroa on survey maps), between Te Paki and Kapo Wairua Road, ca. 700-800ft. (A.W.B.P., February, 1944); S.E. slope of hill behind Pandora, Spirits Bay (A.W.B.P., February, 1944); Hill behind lagoon, Spirits Bay (A.W.B.P., January, 1952); Waterfall gully at Kapo Wairua, Spirits Bay (N. Gardner, March, 1949); Unuwhao, between Spirits Bay and Tom Bowling Bay, 800-900ft. (A.W.B.P.); Coastal cliff, half mile south of North Cape (N. Gardner, January, 1952).

The species is characterised by its large size, broad whorls and narrow apertural flange. It is restricted to the far northern Cape Maria van Diemen-North Cape block, and apart from a local subspecies, described following, is the only *Liarea* found in that area.

Other land snails restricted to this far Northland block, i.e., *Paryphanta watti* Powell, the subfossil *Rhytida duplicata* Suter, its Recent descendant *duplicata vivens* and a number of subspecies of *Placostylus ambagiosus*, all point to former insular isolation of this block from the rest of the Northland Peninsula, to which it is now joined by a long, sandy isthmus lacking in suitable forest covering.

***Liarea aupouria tara* n. subsp. Pl. 48, fig. 34.**

Shell of moderate size, 9.10 mm. to 10.0 mm. in height. Tall-spined but of narrow proportions. Whorl outlines moderately convex, body-whorl rounded without angulation. Suture simple, deeply impressed. Whorls $7\frac{1}{2}$, including a blunt dome-shaped protoconch of two whorls. Spire twice to two and a quarter times height of aperture. Spire height index (i.e., body-whorl width into spire height) 1.68 to 1.89 with an average of 1.77. Umbilicus small, narrowly crescentic. Aperture ovate-rotund, subangled above. Peristome narrow, slightly raised, reinforced around the outer-lip section only by a slight thickening, scarcely a flange. Sculpture in the form of irregular weak axial threads. Colour pattern dark olive brown with a variable hydrophanous epidermal pattern in buff to straw colour. The pattern varies from simple rather diffused axial streaks to intricate zigzags and chevrons. Base uniformly dark or pale with a broad upper spiral band of dark brown.

Holotype: Kerr Point herbfield, North Cape block, among decaying leaves under stunted clumps of *Hebe speciosa brevifolia* Cheesem. on steep northern cliff face. Height 9.1 mm.; diameter 4.0 mm. Auckland Museum.

This subspecies was found in abundance during the Auckland Museum Three Kings Expedition of January, 1953, in Mr. Colin Wild's yacht "Tara."

Although the subspecies bears superficial resemblance to *turriculata* it is at once distinguished by the greatly reduced, almost non-existent, labial flange. Closer inspection reveals the relationship with *aupouria*, the only other *Liarea* from the far northern block, from which it differs in its much smaller size, more slender proportions and more diffused epidermal pattern.

Undoubtedly the local rigorous conditions of the habitat, which afford little shade and is subject to periods of extreme dryness in summer, have induced the development of this distinctive subspecies.

Locality	Smallest	Largest	Average	Spire Ht. Index
Kerr Point	9.10 x 4.10	10.0 x 4.30	9.5 x 4.2	1.77

***Liarea turriculata* (L. Pfeiffer). Pl. 44, fig. 1; Pl. 46, figs. 16-23.**

1855—*Realia turriculata* Pfeiffer Proc. Zool. Soc. (Lond.) for 1854, p. 304.

1865—*Realia turriculata*. Pfeiffer Monog. Pneumopomorum Viventium, 2nd Suppl., p. 170.

Shell of moderate size, 7.2 mm. to 11.7 mm. in height with tall slender spire and a rounded body-whorl. Whorls moderately convex, 7 to 7½, including a small smooth protoconch of two globose whorls. Suture impressed, simple. Spire twice to two and a half times height of aperture. Spire height index (i.e., body-whorl width into spire height) 1.50 to 2.30 with an average of 1.87. Umbilicus a narrow crescent without a margining rib. Aperture ovate, subangled above. Peristome a narrow raised rim surrounded by a moderate to relatively narrow thin flange. Sculpture in well preserved examples of closely spaced regular narrow membranous axials often bearing short minute bristles. Initial coloration yellowish-brown with a broad spiral zone of dark brown on the upper part of the base. After the wearing down of the axials the hydrophanous epidermal pattern develops on the spire. This is usually in the form of bold, somewhat irregular axial streaks. The ground colour of the shell deepens to a dark brown and the porous or lifted areas of the epidermis form the interstices to the pattern. In occasional specimens a tendency towards a zigzag pattern forms on the penultimate and body whorls. In some examples the whole of the base is dark. The apertural flange is brown to dark-brown and the rim of the peristome light brown.

Type: New Zealand. British Museum (Natural History). "9 x 3 2/3 mills." Pfeiffer (loc. cit.) later gave the locality for *turriculata* as Kakepuku (Hochstetter).

Mr. N. Gardner collected a large number of *Liarea* from Mt. Kakepuku, near Te Awamutu, but all are typical *egea egea*.

A drawing made from a photograph of the type specimen kindly supplied by Mr. Wilkins of the British Museum (Pl. 46, fig. 21) clearly shows that the name applies to the form of *Liarea* common around

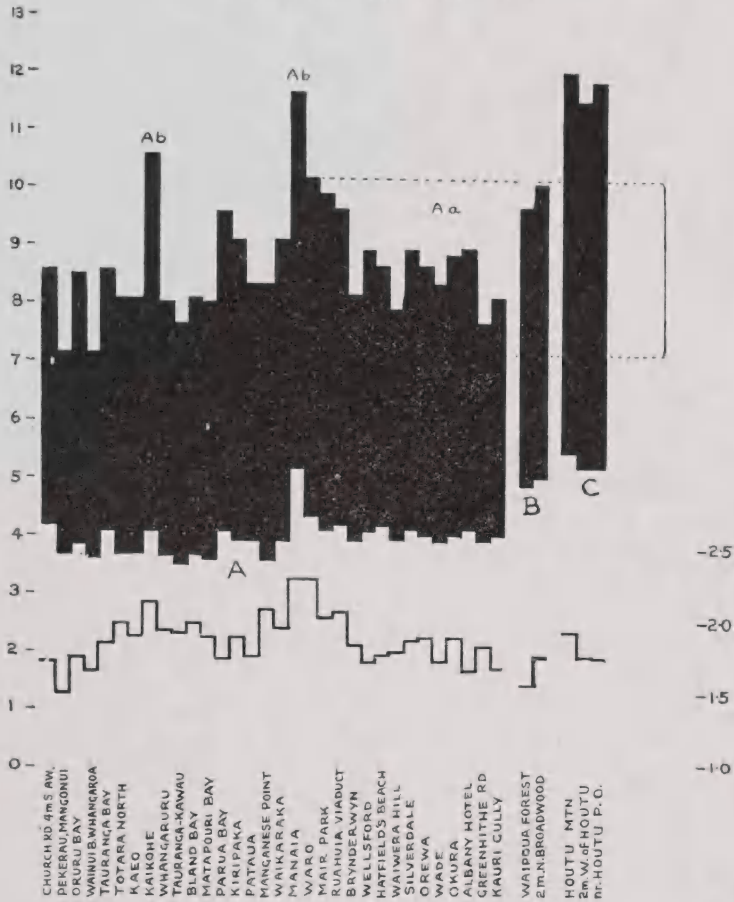


Fig. 4. Histogram of populations for *Liarca turriculata* and subspecies. A = *turriculata turriculata*. B = *turriculata waipoua*. C = *turriculata turriculata* (broad ecotype or subspecies?). Aa = small typical ecotype. Ab = large slender ecotype from broadleaf substrata.

Whangarei and extending up the East Coast of Northland to at least Whangaroa. Mair Park, Whangarei, is here nominated as the type locality for *turriculata*, since Kakepuku is obviously incorrect.

Subspeciation or incipient subspeciation is apparent in the *turriculata* assemblage in the western high country perhumid areas, in the vicinity of Houto Mountain west of Whangarei and again south of Warkworth. The first and last of these merit subspecific nomination, but the second is not named at this stage since there is insufficient material from the vicinity to properly evaluate its relationship to the smaller and proportionately narrower typical subspecies.

It is also noted that in material from near Auckland there is a distinct trend towards a less slender shell as the *egea egea* distributional area is approached or entered, i.e., Albany and Kauri Gully, Northcote.

Locality	Smallest	Largest	Average	Spire Ht. Index
Church Rd., E. of Awapuni	8.50 x 4.00	9.30 x 4.40	8.6 x 4.2	1.72
Pekerau Valley, Mangonui	6.80 x 3.60	8.20 x 3.90	7.2 x 3.7	1.50
Oruru Bay, Mangonui	8.10 x 3.70	9.10 x 4.00	8.5 x 3.8	1.75
Whatuwhiwhi	7.80 x 3.70	8.00 x 3.70	7.9 x 3.7	1.75
Waimui Bay, Whangaroa	7.00 x 3.30	7.90 x 3.90	7.2 x 3.6	1.66

Locality	Smallest	Largest	Average	Spire Ht. Index
Totara North	7.50 x 3.70	9.00 x 3.90	8.1 x 3.7	2.00
Tauranga Bay, Whangaroa	8.00 x 4.20	9.00 x 4.00	8.6 x 4.1	1.89
Kaeo	7.20 x 3.50	9.10 x 4.00	8.1 x 3.7	1.75
Kaikohe	9.60 x 4.20	11.30 x 4.00	10.6 x 4.1	2.14
Home Point, Bland Bay	7.80 x 3.70	8.50 x 3.90	8.1 x 3.7	2.00
Whangaruru	7.70 x 3.50	8.40 x 3.80	8.0 x 3.7	1.93
Tauranga-Kawau Point	7.10 x 3.40	8.20 x 3.70	7.7 x 3.5	1.91
Helena Bay	7.70 x 3.70	8.20 x 3.70	7.9 x 3.6	1.96
Matapouri Bay	7.60 x 3.20	8.20 x 3.90	8.0 x 3.6	1.90
Kiripaka	8.00 x 3.80	10.30 x 4.10	9.1 x 3.9	1.90
Pataua	8.00 x 3.90	8.50 x 4.00	8.3 x 3.9	1.76
Manaia	11.00 x 5.20	12.90 x 5.30	11.7 x 5.2	2.30
Parua Bay	9.20 x 4.00	10.10 x 4.30	9.6 x 4.1	1.74
Manganese Point	7.90 x 3.40	8.90 x 3.50	8.3 x 3.6	2.10
Waikaraka, Onerahi	8.00 x 3.80	10.00 x 3.90	9.1 x 3.9	1.96
Waro, Hikurangi	9.80 x 4.00	10.80 x 4.80	10.2 x 4.3	2.30
Mair Park, Whangarei	9.00 x 4.00	10.40 x 4.40	9.9 x 4.1	2.03
Ruahua Viaduct	9.00 x 3.90	10.50 x 4.50	9.7 x 4.2	2.08
Brynderwyn Hill	8.00 x 4.00	8.50 x 4.00	8.2 x 3.9	1.83
1½ miles S. of Pukapuka Rd.	8.50 x 4.10	9.40 x 4.10	8.9 x 4.1	1.72
South side Waiwera Hill	7.60 x 3.60	8.25 x 4.00	7.9 x 3.9	1.80
Hatfield's Beach	8.20 x 4.10	9.30 x 4.40	8.7 x 4.2	1.79
Orewa	8.00 x 3.80	10.00 x 4.20	7.8 x 4.0	1.90
White Hills, Silverdale	8.40 x 4.00	9.50 x 4.25	8.9 x 4.1	1.89
Wade Estuary	8.00 x 3.90	8.50 x 4.00	8.3 x 3.9	1.72
Okura	8.30 x 4.00	9.10 x 4.10	8.8 x 4.0	1.90
Aibany	8.70 x 4.10	9.10 x 4.20	8.9 x 4.1	1.67
Greenhithe Road	7.60 x 3.90	8.00 x 3.90	7.7 x 3.9	1.83
Kauri Gully, Northcote	7.90 x 4.10	8.40 x 3.90	8.1 x 4.0	1.69
Average of combined averages of above lots:			8.7 x 3.9	1.87

Dentition: Pl. 48, fig. 40. Houto Mountain, west of Whangarei.

Localities: Church Road, near Kaingaroa, east of Awanui (A.W.B.P.); head of Pekerau Valley, near Lake Ohia, Mangonui (A.W.B.P., January, 1948); Oruru Bay, Rangiawhia Peninsula, Doubtless Bay (A.W.B.P., 21/1/1950); Whatuwhiwhi, Rangiawhia Peninsula (D. Forsyth); Wainui Bay, Whangaroa (R. K. Dell); Totara North (W. La Roche); Tauranga Bay, near Whangaroa (N. Gardner, 28/12/1949); Kaeo (Mrs. I. Worthy); Pupuke, near Whangaroa (Mrs. I. Worthy); Kaikohe (R. Cumber); Home Point, Bland Bay (A.W.B.P., 7/2/1948); Whangaruru, northern headland (A.W.B.P., 9/2/1948); Tauranga Kawau Point, north of Whananaki (N. Gardner, October, 1947, Map N. 16, Ref. 949285); Helena Bay (N. Gardner, October, 1949); Matapouri Bay (A.W.B.P.); Kiripaka Reserve, near Ngunguru (A.W.B.P.); Pataua, half mile back from beach, near Whangarei Heads (A.W.B.P., January, 1948); Manaia, Whangarei Heads (R. K. Dell); Manganese Point, Parua Bay, Whangarei (A.W.B.P., 26/10/1947); Waikaraka, Onerahi-Parua Bay Road, Whangarei (N. Gardner, 26/10/1947, Map N. 20, Ref. 900927); Waro, Hikurangi (A.W.B.P., 18/11/1950); Mair Park, Whangarei (N. Gardner, 1947); Houto Mountain, west of Whangarei (E. Fairburn); East slope of Houto Mountain, near Houto Post Office, Mangakahia District (A.W.B.P., 25/10/1947, Map N. 19, Ref. 507916); Maungatapere highway, 1¼ miles east of Parakao, north side of road (A.W.B.P., 25/10/1947, Map N. 19, Ref. 504986); Three miles south of Parakao (N. Gardner, October, 1947); Five miles west of Titoki (N. Gardner, October, 1947); Ruahua Viaduct, Parakao-Kiripokuni Road, Mangawahia District (A.W.B.P., 28/10/1947, Map N. 19, Ref. 477941); Kaihu (H. Suter coll.); Maungaturoto (A.W.B.P., 28/11/1927); Brynderwyn Hill, near Kaiwaka (A.W.B.P., 1/4/1947); 1½ miles south of Pukapuka Road, south of Warkworth (N. Gardner, 27/3/1943); South side of Waiwera Hill (N. Gardner, September, 1947); north end of Hatfield's Beach, near Waiwera (N. Gardner, October, 1947); Eare's Bush, Orewa (A. E. Brookes, 1944); White Hills, near Silverdale (N. Gardner, 11/10/1947); Wade (Weite) Estuary, ridge, south side near mouth, ca. 300ft. (A.W.B.P., 26/12/1949); Okura, near Wade River (A.W.B.P., 24/1/1949); Hobson Road, near Albany (N. Gardner, 11/10/1947); half mile along Greenhithe Road from main highway (N. Gardner, August, 1947); Kauri Gully, Northcote (N. Gardner, October, 1947).

***Liarea turriculata waipoua* n. subsp. Pl. 44, fig. 3; Pl. 48, fig. 36.**

Shell of moderate size, 7.6 mm. to 10.30 mm. in height, tall-spired with a proportionately wide body-whorl and a rapidly tapered spire, with rather straight outlines. Whorls only slightly convex. Whorls 7 to $7\frac{1}{2}$, including a small semi-globose protoconch of two smooth whorls. Suture impressed, simple. Spire twice height of the aperture. Spire height index (i.e., body-whorl width into spire height) 1.48 to 1.76 with an average of 1.66. Umbilicus a narrow crescent without a margining rib. Aperture ovate-rotund, subangled above. Peristome a narrow, slightly raised rim surrounded by a moderate to relatively narrow thin flange. Sculpture of closely spaced, regular, narrow, membranous axials bearing short minute bristles. Colour uniform brown to dark reddish brown with a spiral zone of darker brown upon the upper part of the base. In some examples (Broadwood) there is an indistinct paler zone immediately above the basal band on the body-whorl and also below the suture on the spire whorls.

No examples so far taken exhibit a hydrophanous pattern, but in aged examples the whole epidermis lifts and becomes pale yellowish-brown.

Holotype: Waipoua Forest, Northland (N. Gardner). Auckland Museum. Height 10.6 mm.; diameter 5.1 mm.

Locality	Smallest	Largest	Average	Spire Ht. Index
North side Mangamuka	7.60 x 3.90	9.40 x 4.60	8.3 x 4.1	1.76
Broadwood	10.10 x 4.90	10.30 x 4.90	10.2 x 4.9	1.75
Waipoua Forest	8.70 x 5.00	10.60 x 5.10	9.6 x 5.0	1.48
Average of combined averages of above lots:			9.2 x 4.5	1.66

Localities: Waipoua Forest, Northland (N. Gardner, 2/1/1950) (type); two miles north of Broadwood (N. Gardner, 2/1/1950).

***Liarea turriculata partula* n. subsp. Pl. 48, fig. 35.**

Shell small, 7.0 mm. to 8.2 mm. in height with broadly conical spire of slightly bulging outline. Whorls 6 to $6\frac{1}{2}$, including a blunt dome-shaped protoconch of two whorls. Whorls moderately convex, body-whorl rounded. Suture simple, impressed. Spire one and a-half to one and one-third times height of aperture. Spire height index (i.e., body-whorl width into spire height) 1.17 to 1.41 with an average of 1.30. Umbilicus a relatively large crescent with a weak margining rib. Aperture oblique ovate-rotund, subangled above. Peristome a narrow, raised rim surrounded by a wide thin flange. Surface polished, sculptured with distant subobsolete oblique narrow membranous axials. Colour pale brown to light reddish-brown with a dark reddish-brown spiral band at the top of the base. Variations range from uniform pale yellowish-brown to reddish-brown with a dark red-brown base. Hydrophanous pattern absent.

Holotype: $1\frac{1}{2}$ miles south of Pukapuka Road near main highway south of Warkworth (N. Gardner, 28/3/1948). Auckland Museum. Height 8.2 mm.; diameter 4.6 mm.

Locality	Smallest	Largest	Average	Spire Ht. Index
$1\frac{1}{2}$ miles S. Pukapuka Road	7.00 x 4.00	8.20 x 4.70	7.7 x 4.3	1.30

This subspecies has the simple suture and rounded body-whorl of *turriculata* coupled with the wide labial flange, open rim-margined umbilicus and lack of hydrophanous epidermal pattern, features characteristic of *hochstetteri*. With it occurs typical *turriculata* but not *hochstetteri*. The subspecies may well have had a hybrid origin, but it seems now to be stabilized, for there appear to be no intermediate forms between it and *turriculata*.

Deciding its taxonomic position in harmony with an admittedly arbitrary nomenclatural system is difficult, and in aligning the subspecies with *turriculata* I have presumed a *turriculata* dominance on the evidence of the simple suture, rounded body-whorl and lack of strong axial sculpture.

The subspecies is known only from the type locality, but a large block of surrounding country remains to be investigated.

Liarea lepida (Suter). Pl. 44, fig. 8.

1904—*Realia turriculata lepida* Suter, Proc. Malac. Soc. 6, p. 157.

1913—*Realia turriculata lepida*: Suter Man. N.Z. Mollusca, p. 197.

Shell small, 6.3 mm. to 7.9 mm in height with narrowly conical straight sided spire. Whorl outlines convex, body-whorl rounded. Suture simple, deeply impressed. Spire a little more than twice height of aperture. Spire height index (i.e., body-whorl width into spire height) 1.41 to 1.65, with an average of 1.55. Umbilicus crescentic, narrow but deep. Aperture ovate-rotund, subangled above. Peristome a narrow slightly raised rim margined externally but not across the parietal wall with a relatively wide thin flange. Sculpture of closely spaced regular very oblique narrow membranous axials, becoming obsolete over the body-whorl and absent from the base. Colour pale olive, with a hydrophanous pattern of irregular pale buff maculations, or similar patterning in darker-brown. The base is uniformly olive to dark brown without markings or zones.

Holo:ype: Forty-mile Bush, near Mauriceville (H. Suter). Dominion Museum, Wellington.

Locality	Smallest	Largest	Average	Spire Ht. Index
Poison Point, Masterton	7.00 x 3.90	7.40 x 3.70	7.2 x 3.8	1.65
Mauriceville	6.25 x 3.40	7.75 x 4.00	7.0 x 3.7	1.54
Hastwell	6.30 x 3.40	6.80 x 4.00	6.5 x 3.6	1.41
Manawatu Gorge	7.80 x 3.90	7.90 x 4.00	7.8 x 3.9	1.62
Florida Road, Levin	7.50 x 4.00	7.60 x 4.00	7.5 x 4.0	1.44
Average of combined averages of above lots:			7.2 x 3.8	1.55

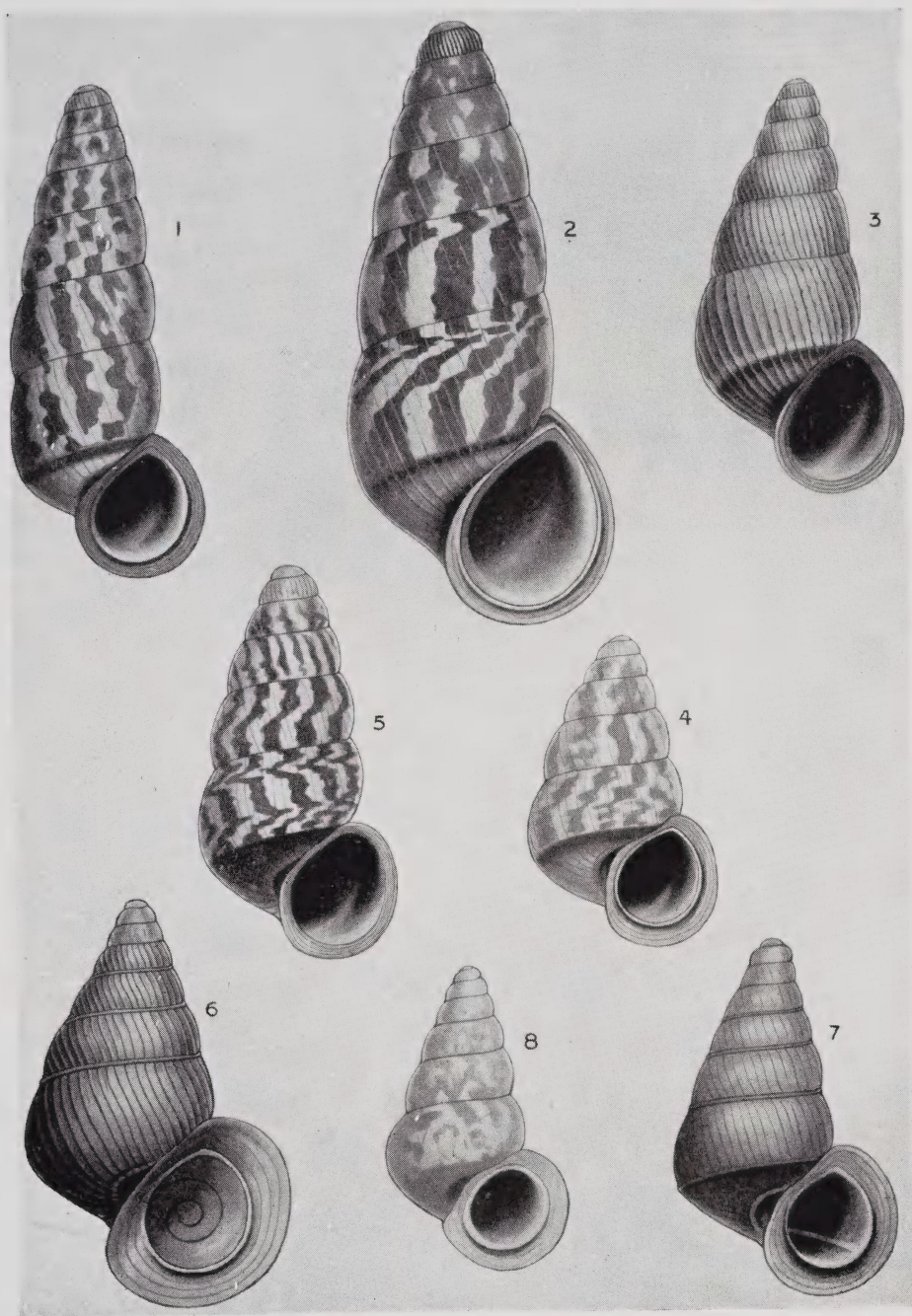
Suter made his *lepida* a subspecies of *turriculata*, but it is better evaluated as a distinct species characterized by its many slowly increasing whorls and straight spire outlines. Its distributional area is far removed from that of the Northland *turriculata* and it is much more likely to have had a common ancestry with the *egea* group. From *egea* it is readily distinguished by the same differentiating characters cited in reference to *turriculata*.

It is the most southern *Liarea* known and has a compact area of distribution ranging from Northern Wairarapa through the Manawatu Gorge and down the Horowhenua coastal plain.

Localities: Forty-mile Bush, near Mauriceville (type); Hastwell; Seventy-mile Bush, near Ormondville (H. Suter); Poison Point, Masterton (Powell coll., Auckland); Manawatu Gorge (A. E. Brookes); Florida Road, Levin (N. Gardner, 28/12/1952).

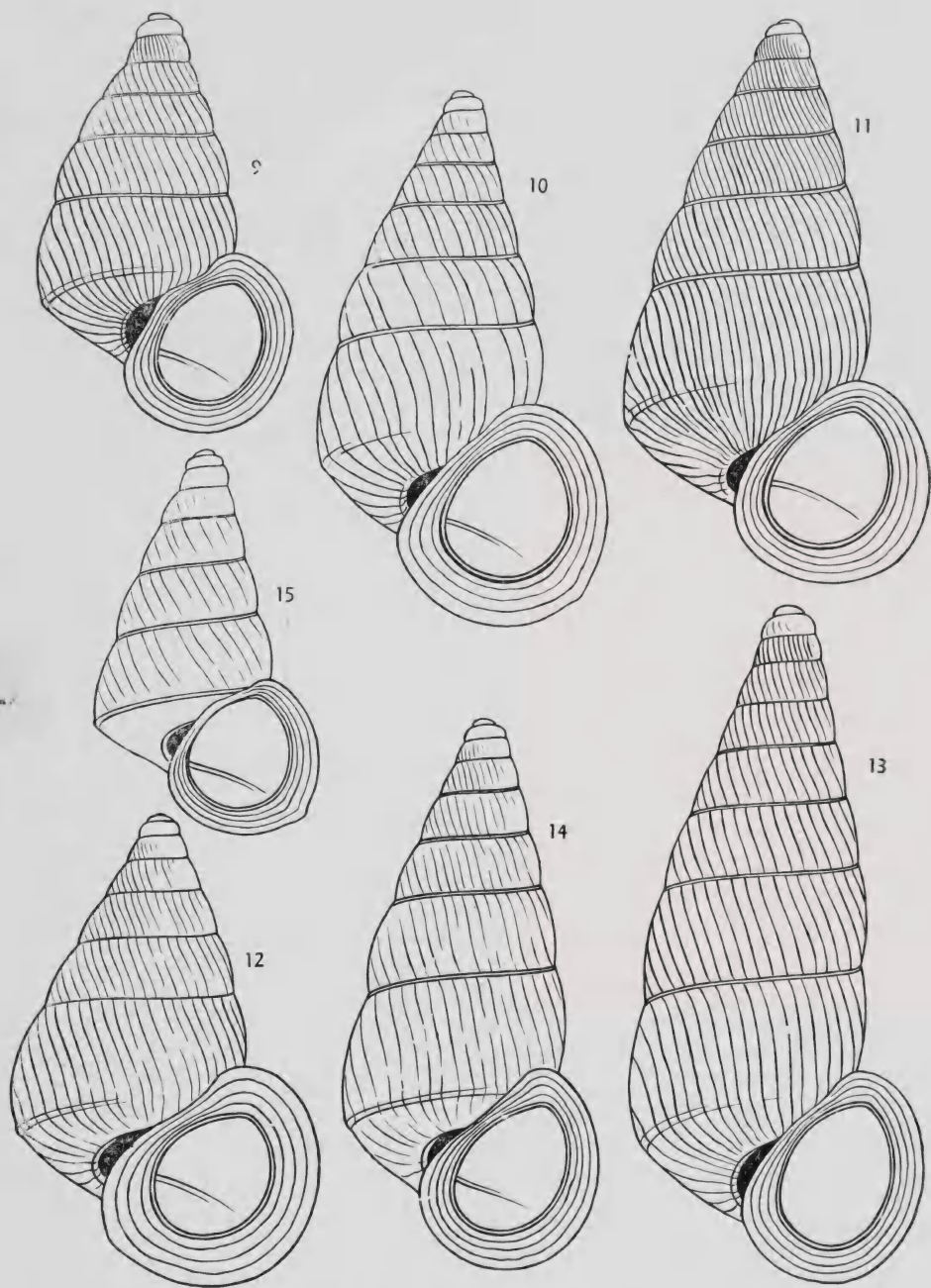
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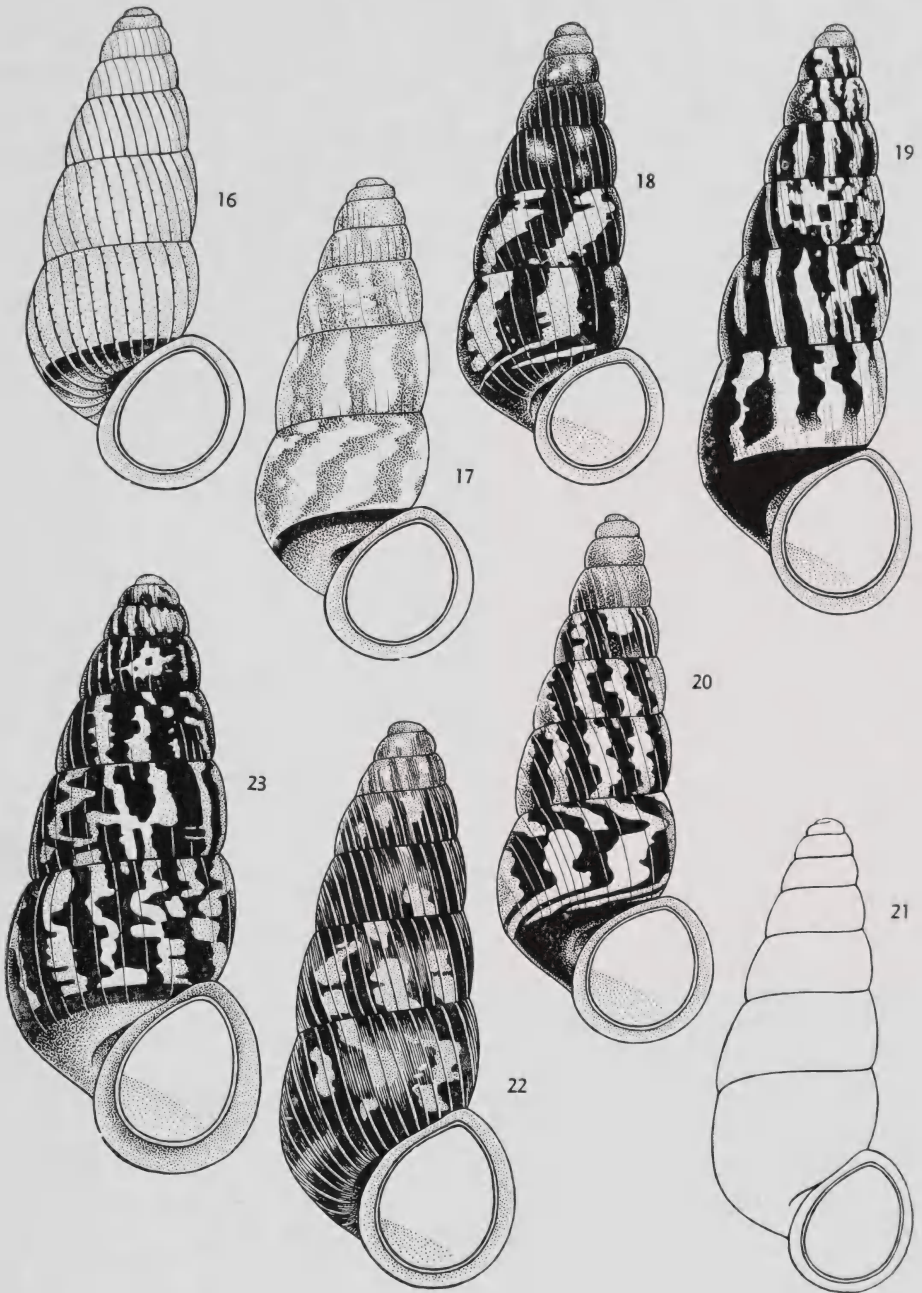
- Fig. 1. *Liarca turriculata turriculata* (Pfeiffer) Mair Park, Whangarei (10.6 mm. x 4.1 mm.).
- Fig. 2. *Liarca aupouria aupouria* n. sp. Unuwahao, 850-900 feet, Northland (Holotype, 13.2 mm. x 6.00 mm.).
- Fig. 3. *Liarca turriculata waipoua* n. subsp. Waipoua Forest, 8.9 mm. x 4.5 mm.).
- Fig. 4. *Liarca egea egea* (Gray). Orakei Bush, Auckland (6.75 mm. x 4.00 mm.).
- Fig. 5. *Liarca egea tessellata* n. subsp. Opononi, Hokianga (Holotype, 8.7 mm x 4.5 mm.).
- Fig. 6. *Liarca hochstetteri hochstetteri* (Pfeiffer), near Awanui (ecotype with extra large labial flange. 8.5 mm. x 5.5 mm.).
- Fig. 7. *Liarca hochstetteri carinella* (Gray). Muriwai, Auckland, West Coast (7.7 mm. x 4.6 mm.).
- Fig. 8. *Liarca lepida* (Suter). Forty-mile Bush, Mauriceville (Topotype, 7.0 mm. x 3.7 mm.).

(Figures 1-8 to uniform scale)



- Fig. 9. *Liarca hochstetteri hochstetteri* (Pfeiffer). Two miles West of Tupou Bay, Mangonui (7.9 mm. x 5.0 mm.).
- Fig. 10. *Liarca hochstetteri hochstetteri* (Pfeiffer). North side of Waiwera-Puhoi Hill (10.25 mm. x 5.75 mm.).
- Fig. 11. *Liarca hochstetteri hochstetteri* (Pfeiffer). Maxwell's Farm, Omahuta (11.0 mm. x 6.0 mm.).
- Fig. 12. *Liarca hochstetteri hochstetteri* (Pfeiffer). Near Awanui (Wide labial flange ecotype) (9.00 mm. x 5.75 mm.).
- Fig. 13. *Liarca hochstetteri alta* n. subsp. Between Tauraroa and Waitotira (Holotype, 12.75 mm. x 5.60 mm.).
- Fig. 14. *Liarca hochstetteri alta* n. subsp. (pale coloured ecotype). Houto Mountain, west of Whangarei (10.5 mm. x 5.0 mm.).
- Fig. 15. *Liarca hochstetteri carinella* (Pfeiffer). Muriwai, West Coast, Auckland (7.0 mm x 4.0 mm.).

(Figures 9-37 to uniform scale)



- Fig. 16. *Liarea turriculata* (Pfeiffer) (Initial sculpture and pattern). Waikaraka, Onerahi.
- Fig. 17. *Liarea turriculata* (Pfeiffer) (Worn sculpture plus hydrophanous pattern). Waikaraka, Onerahi.
- Fig. 18. *Liarea turriculata* (Pfeiffer). Whangaruru (8.6 mm. x 4.0 mm.).
- Fig. 19. *Liarea turriculata* (Pfeiffer). Mair Park, Whangarei (11.0 mm. x 4.0 mm.).
- Fig. 20. *Liarea turriculata* (Pfeiffer). Waro, Hikurangi (10.0 mm. x 4.0 mm.).
- Fig. 21. *Liarea turriculata* (Pfeiffer). From photograph of holotype.
- Fig. 22. *Liarea turriculata* (Pfeiffer). Between Houto Post Office and Titoki (10.5 mm. x 4.5 mm.).
- Fig. 23. *Liarea turriculata* (Pfeiffer) (Broad ecotype or subspecies?) Eastern slope of Houto Mountain (11.3 mm. x 5.0 mm.).



Fig. 24. *Liarca egea tessellata* n. subsp. Opononi, Hokianga (Holotype) 8.7 mm. x 4.5 mm.).

Fig. 25. *Liarca egea tessellata* n. subsp. Ruahua Viaduct (10.0 mm. x 4.9 mm.).

Fig. 26. *Liarca egea tessellata* n. subsp. Woodcocks (9.1 mm. x 4.75 mm.).

Fig. 27. *Liarca egea egea* (Gray). Te Puke (6.6 mm. x 3.8 mm.).

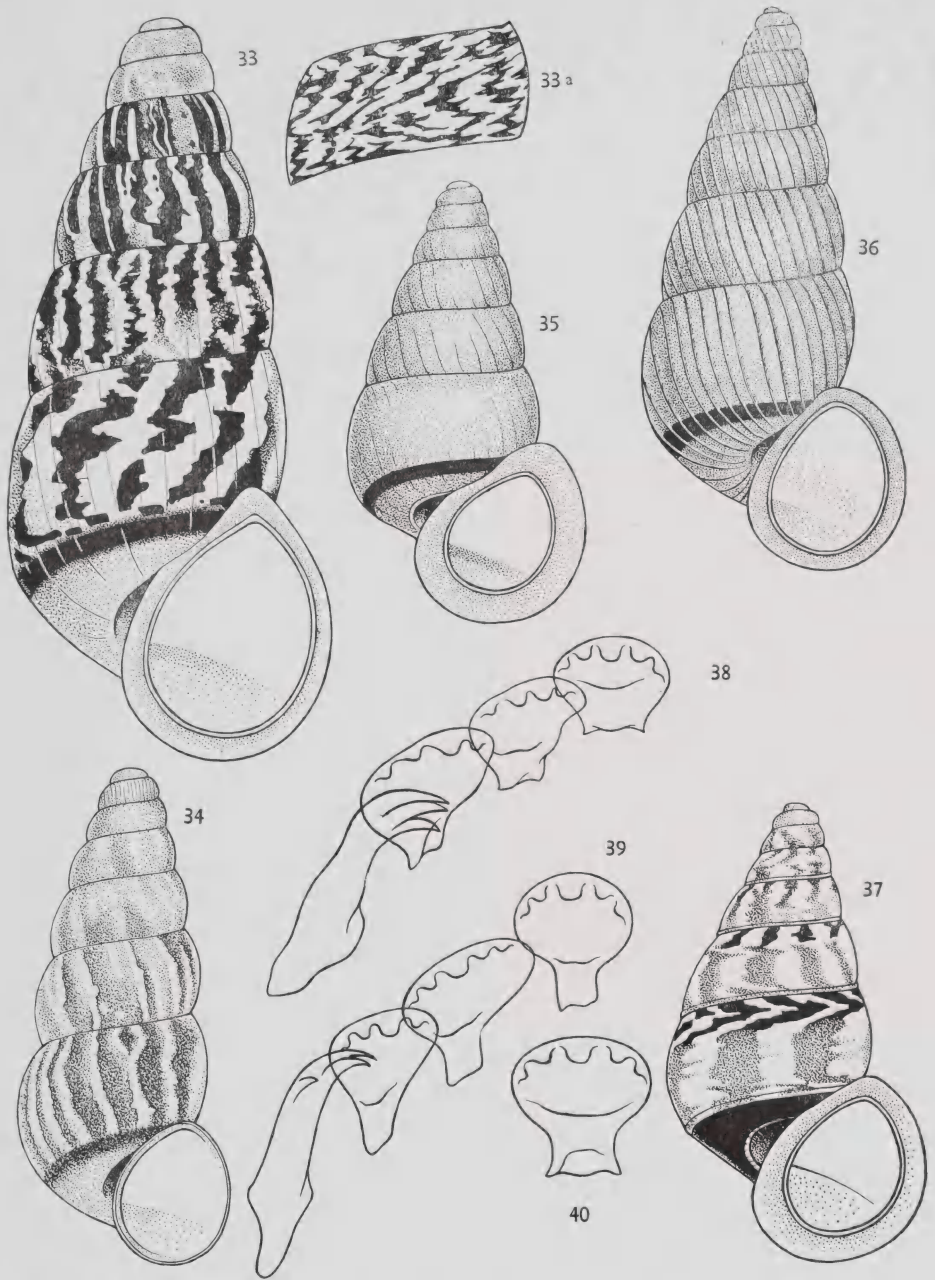
Fig. 28. *Liarca egea egea* (Gray). Mt. Kakepuka (6.35 mm. x 3.60 mm.).

Fig. 29. *Liarca egea egea* (Gray). Chickens Islands (7.1 mm. x 4.1 mm.).

Fig. 30. *Liarca egea egea* (Gray). Greenhithe, Auckland (7.6 mm. x 4.6 mm.) (Initial sculpture and pattern).

Fig. 31. *Liarca egea egea* (Gray). Mountain Road, Mt. Eden, Auckland. (7.6 mm. x 4.9 mm.)

Fig. 32. *Liarca egea egea* (Gray). Orakei Bush, Auckland. (6.9 mm. x 4.0 mm.)



- Fig. 33. *Liarea aupouria aupouria* n. sp. Unuwaho, Northland. (Holotype, 13.20 mm x 6.0 mm.) 33a. Extreme zigzag pattern.
- Fig. 34. *Liarea aupouria tara* n. subsp. Kerr Point, Northland. (Holotype, 9.1 mm. x 4.0 mm.)
- Fig. 35. *Liarea turriculata partula* n. subsp. Pukapuka Road, south of Warkworth. (Holotype, 8.2 mm. x 4.6 mm.)
- Fig. 36. *Liarea turriculata waipoua* n. subsp. Waipoua Forest, Northland (Holotype, 10.6 mm. x 5.1 mm.).
- Fig. 37. *Liarea ornata* n. sp. Three miles south of Wellsford (Holotype, 8.4 mm. x 5.0 mm.).

DENTITION.

- Fig. 38. *Liarea egea egea* (Gray). Whitford, Auckland.
- Fig. 39. *Liarea hochstetteri hochstetteri* (Pfeiffer). Kaeo, Northland.
- Fig. 40. *Liarea turriculata turriculata* (Pfeiffer). Houto Mountain, west of Whangarei.